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together rather than separately. One example is collaboration with Israel on tourism. Since the signing of the Oslo Accords, a number of hotels and restaurants in the West Bank and Gaza complained that tourists often made only day trips to Palestinian sites while staying and spending their money in Israel. Joint promotion of cultural sites (especially in East Jerusalem) and investment in the surrounding areas and border crossings would help to increase the number of tourists to both countries as well as the amount of money spent in each.

Jordan and Egypt also provide opportunities for cooperation, although it is unlikely that such cooperation would be as extensive as with Israel because these countries are poorer, have similar mixes of production factors (plenty of unskilled labor), and do not have a history of cooperation. Nevertheless, successful Arab partnerships could be built in the areas of tourism, energy, water, transportation, and potentially manufacturing.

We recommend the following:

- In the case of high economic integration with Israel, Palestine should collaborate with Israel to coordinate the development of tourism and other sectors.
- In all cases, an independent Palestine should pursue cooperative ventures with Jordan and Egypt.
- Israel, Palestine, Egypt, and Jordan should seek to make customs procedures as easy and transshipment costs as cheap and swift as possible. These countries should invest in infrastructure at border crossing points (bridges, highways, railroads, and customs points) to ensure that movement and transshipment proceed quickly and efficiently.

### Investing in Infrastructure

In light of the poor quality of infrastructure in much of Palestine and the severe damage inflicted on it during the second intifada, a large program of infrastructure construction will be required, regardless of the scenario in which Palestine finds itself. Transportation infrastructure will need to be developed to speed the movement of goods and people. Palestine will need roads, bridges, and transportation hubs, such as seaports and airports, for travel and trade within Palestine and with its neighbors. Investments in electricity, water, and sewage infrastructure will be needed to expand services, thereby improving living conditions and increasing the competitiveness of domestic industries. Investments in communications and information technology will be needed to lay the foundations for the emergence of profitable new industries and for future economic growth.

How extensive these projects need to be, especially with respect to power, water, and sanitation, depends to some degree on the extent of economic cooperation between Palestine and Israel. Since per-capita GDP in Palestine is only one-tenth of Israel's, the Palestinian government will have to prioritize where it spends its limited resources, especially on investment in infrastructure. Where possible, it would make sense to utilize infrastructure in neighboring countries, including Israel. If, for example, the Israeli elec-

tricity grid currently serving the West Bank and Gaza provides a quality, cost-competitive service, it would make more sense for Palestine to contract with Israel for these transmission services than to build a new Palestinian system from scratch. The use of Israeli or Jordanian airports is likely to be cheaper than building, operating, and maintaining separate Palestinian facilities. If economic integration with Israel is low, however, Palestine will have no choice but to try to construct its own electric power system and transportation infrastructure, although it is important to recognize that the conditions—particularly relating to security—that would inhibit integration with Israel are also likely to inhibit unrestricted Palestinian development of this type of infrastructure.

Egypt and Jordan could work with Palestine to improve regional infrastructure, especially regarding transportation and energy, which would support economic development broadly and help ease Palestinian dependence on Israel. Oil pipelines to Jordan could be extended to link Palestine with Iraqi or Saudi oil fields. Gas pipelines could be constructed to Iraqi fields. Another possibility would be the creation of a Palestinian electrical grid linked to a regional grid encompassing Egypt, Jordan, Syria, Lebanon, and Israel. This system could be based on existing links (UNCTAD, 1998).

Under all scenarios, projects critical to fostering Palestinian economic growth include

- expanding power, water, and sewage plants
- constructing a Gaza seaport
- ensuring unrestricted access to regional airports, whether they are located in Israel or Jordan, or involve rebuilding the Gaza airport and adding cargo facilities
- developing a corridor linking the West Bank and Gaza
- improving border crossings with Jordan and Egypt.

In addition to the benefits generated by the completed infrastructure, the construction of these projects would benefit the Palestinian economy. Contracting these projects to the domestic private sector would foster development of private Palestinian construction firms and generate employment. Mixed foreign and domestic management of construction projects would facilitate the transfer of project management skills and construction technologies. Such strategies would build the domestic construction industry, bringing it to a level where Palestinian firms could provide construction services to the rest of the world, especially to countries within the Middle East.

We recommend the following:

- In the case of high economic integration, Palestine should leverage Israeli infrastructure wherever possible.
- Israel should encourage the development of common infrastructure with Palestine. Although charges will need to recover the full costs of the service, Israel should price these services as competitively as possible.

- Under all scenarios, Egypt and Jordan should seek to develop common infrastruc-ture with Palestine wherever cost-effective.
- International financial institutions should support cross-border infrastructure projects.
- Whenever possible, donor-financed projects should encourage use of mixed for-eign and domestic management of construction projects.

### Easing Palestinian Employment in Israel

Whether a final agreement permits significant access for Palestinian labor to Israel or only limited access, it is important that this access be as easy as possible. Employment opportunities in Israel with their relatively higher wages are a much needed source of income that helps to fuel Palestine's domestic economy. Thus, efforts to minimize impediments to Palestinians reaching their jobs in Israel would be beneficial, includ-ing streamlining bureaucratic procedures (e.g., to obtain permits) and facilitating easy border crossings.

At the same time, this access should be provided in a manner consistent with Israel's need to maintain security. As mentioned earlier, the primary constraint on Pal-estinian employment in Israel is security—the Israeli government wants to ensure that no Palestinians in Israel engage in attacks on Israelis and has used border closures and other restrictions to restrain or discourage attacks. So Palestinian cooperation and col-laboration with Israel in implementing security measures would help to increase the Israeli government's comfort level and, over time, could potentially help to increase the extent of Palestinian access to Israel.

We recommend the following:

- Palestine should adopt and implement the security measures that would make employment of Palestinians in Israel possible.
- Assuming security measures are adequate, the Israeli government should make it easy for Israeli employers to hire Palestinians by streamlining and reducing the cost of the permitting process.
- Israel should give Palestinian workers expedited access to Israel, including acceler-ated processing at borders and rapid, seamless transport links to places of employ-ment.
- Provided security has improved, Israel should revamp rules on overnight stays and other strictures so that Palestinian workers have more flexibility to respond to unexpected occurrences such as the need to stay later at work.

### Expanding Access to Capital

Increasing private-sector access to capital, which has been limited because of political risk and other concerns, would help spur investment. Palestine could undertake a number of initiatives to strengthen its domestic banking sector, including reforming domestic bank-

ing policies and encouraging foreign banks to open branches in Palestine. Such actions could increase financial intermediation and improve the allocation of capital. The World Bank (1999a, pp. 97–109) advocates improving the Palestinian Monetary Authority's (PMA) regulation and supervision of the banking sector by requiring stricter capital adequacy rules, relatively high liquidity ratios, and restrictions on acquiring risky assets. Over the longer term, the PMA could develop mechanisms such as deposit insurance and a discount window to contain bank failures. The mere existence of these regulations and institutions would not guarantee that they would be enforced. However, creating them is a necessary first step for a modern banking system.

Improving the financial system also involves clarifying property rights and improving access to collateral for both borrowers and lenders. The absence of well-defined Palestinian property rights has contributed to disputes between the Israeli and Palestinian communities. The absence of a proper land registry inhibits private-sector borrowing and investment in business by making it difficult to use real property as collateral. A land registration program would facilitate lending and the expansion of residential construction and small business operations.

International programs providing political risk insurance would also help attract both Palestinian and foreign investors to the new state. Political risk insurance reduces the risk to commercial activities stemming from political instability. An insurance program targeted specifically at Palestine and funded by the international community could insure foreign and Palestinian investors against the destruction of property stemming from violence or state expropriation of investment. These guarantees would make it easier for international companies to obtain investment funding. If a separate fund were not set up, guarantees could be obtained from the U.S. Overseas Private Investment Corporation, the World Bank's Multilateral Investment Guarantee Agency, or other such insurance programs.

We recommend the following:

- In accordance with World Bank suggestions, the PMA should tighten lending standards for Palestinian banks and improve oversight procedures.
- International financial institutions should provide training and assistance to the PMA to improve its ability to supervise banks.
- Donors should help the Palestinian Authority create a system of property registration and register all property in the West Bank and Gaza.
- Foreign agencies that provide political risk insurance should offer these services to investors in a new Palestinian state.

## Choosing Currencies

As noted above, the Palestinian Authority does not have its own currency but uses three freely exchanged foreign currencies: the new Israeli shekel, the U.S. dollar, and the Jordanian dinar. This tri-currency system appears to have served the West Bank and Gaza

very well. Despite very tumultuous situations, inflation has remained lower than that in Israel. Because the current system is relatively successful, the Palestinian economy is small, and foreign trade is a very large share of GDP, there appears to be no need for a separate national currency.

Accordingly, we recommend that a new Palestinian state should not create its own currency, but should continue with the current policy of accepting the Jordanian dinar, the new Israeli shekel, and the U.S. dollar as legal tender.

## Improving the Business Climate

Attracting foreign direct investment to Palestine is essential to fostering industrialization and rapid economic growth. When multinational firms locate plants or facilities in a developing country, they bring not only jobs, but also management skills and technologies that spill over into the larger economy. Spillovers occur in a number of ways: when local companies become more efficient by replicating foreign procedures, when local workers leave the multinational firms for local companies, and when multinational firms help improve the capabilities of their local suppliers (Lim, 2001). Foreign direct investment is how countries such as Singapore achieved rapid economic growth.

Improving the transparency and accountability of governance in the Palestinian state would increase investor confidence and encourage flows of foreign capital to fund Palestinian economic development. Improving Palestinian governance involves a broad range of activities, some of which are only tangentially related to economic policy. A number of these key issues and policy changes are addressed in Chapter Two. However, among these policies, one is repeatedly cited: improving the Palestinian legal framework (Sayigh and Shikaki, 1999, 2003; Brown, 2002). These sources and others note the need to strengthen the independence of the judiciary and to eliminate the arbitrary, harsh security courts. Other important measures include improving mechanisms for the resolution of commercial disputes and creating legal guarantees for the repatriation of profits and capital by foreign investors.

Another measure to attract foreign direct investment is to keep the costs of doing business low. One approach is to use economic development zones (EDZs)—enclaves in which customs, registration, and other procedures are simplified and which sometimes offer tax concessions. They are not new to the West Bank and Gaza; they have been discussed throughout the 1990s under the Oslo Accords (and implemented in a limited fashion in Gaza) as a way of marrying Israeli capital with Palestinian labor, providing needed jobs in the West Bank and Gaza while avoiding security concerns associated with thousands of Palestinians crossing into Israel for work. But a bolder program broadly targeted at the entire international community of investors, not just Israeli investment, would prove beneficial in terms of job growth, industrialization, and technology transfer.

However, in Palestine's case, there is little sense in carving out selected areas in which government procedures are expedited. Palestine is so small, geographically (the

size of the San Francisco metropolitan area) and economically, that the Palestinian government would be well advised to eliminate tariffs and simplify business registration and other procedures for the entire country, not just special zones. Governments that create simple, low-cost, transparent procedures for registering and regulating businesses have had some remarkable successes in terms of economic development: Witness Hong Kong, Estonia, and Singapore. Such a step would signal to the international investor community that the Palestinian government seriously wishes to attract foreign investment and support the private sector.

Regardless of whether the Palestinian government simplifies regulations for the entire state or just selected zones, regulations should have the following characteristics: They should be designed to help facilitate the movement of people to their jobs and the movement of goods between port facilities and industrial or agricultural centers. Business regulations should be simple and clear.[29] Procedures for settling commercial disputes should be acceptable to the international financial community. Such rules would provide safeguards to foreign investors and address investor concerns about the rule of law and transparency.

We recommend the following:

- The Palestinian Authority should treat the entire country as an EDZ, focusing on expediting cross-border shipping, customs procedures, and administrative procedures for domestic companies and exporters alike.
- The Palestinian Authority should clarify, update, and improve the commercial code immediately.
- The Palestinian Authority should simplify and reduce the costs of registering businesses as soon as possible.
- The Palestinian Authority should consolidate judicial proceedings in civilian courts and improve judicial proceedings and the quality of judges.
- The Palestinian Authority should permit international arbitration and set up other commercial dispute settlement procedures acceptable to the international financial and investment communities.

### Investing in Human Capital

There is currently a mismatch between the skills of the Palestinian labor force and those most needed in the sectors of the economy most likely to expand. Most university students study liberal arts subjects rather than engineering or sciences, majors that have been more marketable but less popular. Secondary education suffers from high drop-

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[29] This is not to suggest that businesses located in EDZs should be exempt from all environmental or other regulations of importance to the community and country. In fact, any program of EDZs that is implemented in Palestine should be cognizant of the issues sometimes experienced in other countries resulting from foreign direct investment, such as environmental pollution, problems with accountability, and the expropriation of resources. We do suggest, however, that businesses should be shielded from excessive regulation, which is a concern given the relative inexperience of Palestinian governing bodies.

out rates and weak vocational training. High dropout rates may stem from the poor quality of vocational training: Students question the benefit for future employment of poorly designed training courses.

As the Palestinian economy develops and modernizes, it will require a skilled workforce ready to participate in a competitive, global environment. Ensuring that the Palestinian workforce is adequately prepared will require significant investments in human capital. Although we discuss reforms of the education system in more detail in Chapter Eight, we note several areas in which reforms would give Palestinian students more-marketable skills:

- Foreign donors should provide tuition assistance and subsidies to encourage enrollments in the sciences and engineering.
- Foreign donors should work with the Palestinian Authority to improve the quality and appeal of vocational training.

## Conclusions

In this chapter, we examined possible economic development trajectories in an independent Palestinian state during the 2005 to 2019 time frame. We focused on Palestine's prospects for sustaining growth in per-capita incomes over time. In exploring this issue, we discussed the major challenges that will confront the Palestinian economy, as well as the four critical issues—transaction costs, resources, the Palestinian trade regime, and the access of Palestinian labor to employment in Israel—that will determine the conditions under which the Palestinian economy will function. Using a growth accounting model, we then examined how the four scenarios resulting from different levels of contiguity and integration affect per-capita income. The scenario with the highest resulting per-capita income after ten years (high contiguity and high integration) saw incomes 24 percent higher than incomes in the scenario with the lowest resulting per-capita income (low contiguity and low integration). We also discussed best-practice policy options that could aid the Palestinian economy under any conditions.

Decisionmakers should find our framework and analysis useful in two important respects. First, they provide a rough approximation of the magnitude of investments needed to generate rapid recovery and then growth in per-capita incomes in Palestine. They also provide a useful benchmark for the international community with respect to investment decisions for Palestine. Second, they indicate how different conditions could affect economic growth in a Palestinian state. A contiguous Palestine economically integrated with Israel would likely fare far better than a fragmented state or one that has truncated economic ties to Israel. A less contiguous Palestine that is also oriented away from Israel will have trouble sustaining economic growth. Decisionmakers would do well to avoid this scenario if at all possible.

## Appendix 5.A: The Growth Accounting Model

The results described in the section above, Economic Implications of the Scenarios for a Future Palestinian State, are based on a simple growth modeling framework, in which we focus on modeling Palestinian GNI over the period 2005–2019. We define GNI to consist of Palestinian GDP, plus remittances from Palestinian employment in Israel.

Our growth model is intended as a tool for illustrating the economic potential of an independent Palestinian state and the economic opportunity cost of low geographic contiguity and/or low economic integration of this state with Israel. We emphasize that the results from this model follow deterministically from our assumptions about initial levels and trends in Palestinian labor supply and employment rates, capital investment, productivity growth, and the other parameters of the model. Moreover, although our assumptions about these parameters are intended to be realistic, they are not predictive in the sense that we necessarily expect these trends to be realized. Such forecasting, and indeed any type of formal macroeconomic modeling, is outside the scope of this project.

**Gross Domestic Product**

Our growth modeling assumes an initial (end of 2004/beginning of 2005) level of Palestinian GDP of $3.4 billion, which represents a 30 percent decrease from the 2000 level. This assumption is reasonable considering that, according to the World Bank, Palestinian GDP dropped from $4.7 billion in 2000 to $4.2 billion in 2001 (in constant 2003 dollars). Thus increases to GDP in 2005 and beyond resulting from, for example, infusions of capital begin from this base.

To model Palestinian GDP over the period 2005–2019, we use a Cobb-Douglas production function:

$$GDP_{ts} = A_{s} K_t^{\alpha} L_t^{\beta}, \tag{1}$$

where $A$ is total factor productivity (TFP), $K$ is productive capital, $L$ is employment, $\alpha$ is the elasticity of GDP with respect to capital, and $\beta$ is the elasticity of GDP with respect to labor. The subscript $t$ indexes time ($t$ = 2005 to 2019), while the subscript $s$ indexes scenarios ($s$ = high contiguity/high integration, high contiguity/low integration, low contiguity/high integration, and low contiguity/low integration); parameters that are assumed to be constant across time and/or scenarios lack the corresponding subscript.

Under the assumption that production is characterized by constant returns to scale, $\beta = 1 - \alpha$, and Equation 1 can be rewritten as:

$$GDP_{ts} = A_{s} K_t^{\alpha} L_t^{1-\alpha}. \tag{1'}$$

The Cobb-Douglas functional form and the assumption about constant returns to scale are commonly used by economists for national growth modeling.

For this analysis, we must specify the initial conditions for the above variables and parameters (at the end of 2004/beginning of 2005), and then specify how we expect them to change over time in each scenario. In the remainder of this section, we describe the assumptions underlying each variable and parameter in the model. We then report the levels of Palestinian national income that follow from these assumptions.

## Total Factor Productivity (A)

Growth in TFP refers to the process by which technological or other change raises output per unit of capital and labor. For convenience, and without loss of generalizability, we normalize TFP to take the value of 1 in 2004 under all scenarios. For the high-contiguity/high-integration scenario, we assume that TFP growth starts at 7.0 percent annually in 2005 and declines to 3.0 percent annually by 2019.[30] For the high-contiguity/low-integration and low-contiguity/high-integration scenarios, we assume that TFP starts at 6.0 percent annually and declines to 2.0 percent annually. And for the low-contiguity/low-integration scenario, we assume an initial TFP growth of 4.0 percent annually that declines to 1.0 percent annually. The smaller growth rates primarily reflect the higher transaction costs under these scenarios. Our assumptions about TFP are summarized in Table A.5.1.

## Capital Stock (K)

We assume an initial capital stock in 2004 of $12.1 billion. Precise estimates of the capital stock do not exist, particularly because of the damage during the intifada. We arrive at our figure from the World Bank's (2002b) average estimate of the 2000 capital stock ($16.3 billion in 2003 dollars[31]) after accounting for (assumed) total losses of $1.6 billion in 2003 dollars[32] from the intifada and 5 percent annual depreciation.

For all scenarios, we assume the same capital stock growth rates. This assumption makes it easier to compare how the four scenarios affect per-capita GDP. We assume a realistic capital stock growth rate of 10.0 percent in the first year of independence, with a significant bump upward to 20.0 percent in the following year.[33] Capital stock growth returns to 10.0 percent in 2007 and remains there until 2010. Between 2011 and 2019, the annual growth rate is at the historical norm of around 7.0 percent.[34]

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[30] By comparison, the average annual TFP growth in Japan and Germany during the years 1950 to 1973 was 6.4 percent and 5.6 percent, respectively.

[31] The World Bank's estimates of the 2000 capital stock range from $11 billion to $18 billion in constant 2000 dollars. The World Bank assumes that the Palestinian capital stock in 1968 was between 100 percent and 300 percent of GDP, with a median scenario of 200 percent of GDP. The World Bank uses the perpetual inventory method to estimate the change in capital over time, which adds investment and subtracts depreciation, with a depreciation rate of 5 percent. The World Bank reports its assumptions and growth rates in Table VI.1 (2002b), which we use to calculate capital stock in 2000.

[32] The World Bank (2003c) estimated that damage to infrastructure totaled $750 million by August 2002.

[33] Capital stock growth rates are assumed to be net of depreciation.

[34] By comparison, the annual capital stock growth in Japan averaged 12 percent between 1965 and 1970, and then declined to 5 percent for the period 1985 to 1990. This is not to suggest that Palestine will develop along the same

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**Table A.5.1**
**Assumptions About Total Factor Productivity (A)**

| Scenarios | Initial Level (2004) | Annual Average Change (%) | | |
|---|---|---|---|---|
| | | 2005–2009 | 2010–2014 | 2015–2019 |
| High contiguity/high integration | 1.0 | 5.0 | 3.0 | 3.0 |
| High contiguity/low integration | 1.0 | 4.3 | 2.2 | 2.0 |
| Low contiguity/high integration | 1.0 | 4.3 | 2.2 | 2.0 |
| Low contiguity/low integration | 1.0 | 2.4 | 1.0 | 1.0 |

**Table A.5.2**
**Assumptions About Average Annual Change in Palestinian Capital Stock (K)**

| | 2005–2009 | | 2010–2014 | | 2015–2019 | |
|---|---|---|---|---|---|---|
| | % | $ (billions) | % | $ (billions) | % | $ (billions) |
| All scenarios | 12.0 | $2.6 | 7.6 | $3.1 | 7.0 | $4.2 |

Our assumptions about the capital stock are summarized in Table A.5.2, based on an initial (2004) capital stock of $12.1 billion. Under these assumptions, total investment would be $13.1 billion between 2005 and 2009, resulting in an average annual increase of $2.6 billion; and $15.6 billion between 2010 and 2014, resulting in an average annual increase of $3.1 billion. The ten-year total would be $28.7 billion.

### Elasticity of GDP with Respect to Capital ($\alpha$)

We assume $\alpha$ to be 0.4 across all scenarios for all years. Correspondingly, we assume $\beta$ to be 0.6 across all scenarios for all years. These values are identical to World Bank (2002c) estimates and are also common in cross-country growth studies.

### Labor Force

As described in the section above, Principal Challenges and Critical Issues Confronting the Palestinian Economy, the Palestinian labor force was approximately 625,000 in 2000, and population growth has caused it to increase rapidly. For purposes of modeling economic growth during the period 2005–2019, we rely on the IMF's (2001) labor force projections for 2000–2005, 2010, 2015, and 2020, using a simple linear projection for the years between those estimated by the IMF.

These projections assume zero net migration. Even so, they yield an average annual labor force growth rate of 4.4 percent throughout the period, high compared to

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lines as Japan. Rather, the Japanese case is instructive because it presents an example of an economy recovering from the ravages of war. Looking at other countries, capital stock growth in South Korea averaged 15 percent between 1965 and 1970, and then declined to 9 percent between 1985 and 1990. In Singapore, the figure was about 11 percent between 1980 and 1985 and about 8 percent between 1990 and 1998. For reference, the historical capital stock growth (both productive and residential) in the West Bank and Gaza averaged just over 7 percent during the 30 years prior to the second intifada.

Table A.5.3
Assumptions About Average Annual Change in Palestinian Labor Force

|  | 2005–2009 | | 2010–2014 | | 2015–2019 | |
| --- | --- | --- | --- | --- | --- | --- |
|  | % | N (thousands) | % | N (thousands) | % | N (thousands) |
| All scenarios | 23.5 | 182.4 | 23.1 | 222.6 | 22.4 | 268.1 |

SOURCE: RAND Corporation calculations based on IMF (2001).
NOTE: N = number in the Palestinian labor force.

most other middle-income developing countries. The Palestinian labor force—and the requirements of job creation—will obviously rise with immigration, e.g., by Palestinians from the diaspora.

Our assumptions about the Palestinian labor force are summarized in Table A.5.3, based on an initial (2004) labor force of 743,500.

### Employment in Israel

Palestinian employment in Israel, and in Israeli settlements in the West Bank and Gaza, has fallen from 135,000 in 1999 to approximately 57,000 in 2003. Given the recent turmoil, we assume an initial level (2004) of 40,000 Palestinians in Israel. We assume that employment in Israel recovers very quickly in the high-economic-integration scenarios: In these scenarios, we assume that 130,000 Palestinians are employed in Israel in 2005, similar to employment levels before the intifada. In the low-integration scenarios, we assume that Palestinian employment in Israel only numbers 20,000 in 2005. In both high-integration scenarios, we allow for 2.0 percent annual growth thereafter; in both low-integration scenarios we allow for slightly higher growth of 3.5 percent.

Table A.5.4 summarizes our assumptions about Palestinian employment in Israel.

### Domestic Employment (L)

**Domestic Public Employment.** In calculating GDP via our growth accounting model (Equation 1), we define labor as domestic employment. Domestic employment consists of public-sector employment and private-sector employment.

We assume that initial (2004) public-sector employment is 110,000, which is comparable to the level of employment in the Palestinian Authority in 2000. We assume that public-sector employment increases to 115,000 in 2005, and then increases thereafter by 1.0 percent annually in the high-economic-integration scenarios, and by 2.5 percent annually in the low-economic-integration scenarios.[35]

Table A.5.5 summarizes our assumptions about Palestinian domestic public employment, based on an initial (2004) level of 110,000.

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[35] The small public-sector growth rate under high economic integration balances the widespread view that the PA is already too large with the view that a growing population and economy would demand an increase in government services. The higher growth rate under low economic integration reflects the fact that the public sector would have to compensate for fewer private-sector jobs under these scenarios.

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**Domestic Private Employment.** Our approach regarding domestic private employment in Palestine is somewhat different than for the other variables we consider here. Our assumptions about all other variables—TFP, productive capital, labor force, private employment, employment in Israel—are informed by empirical data (from the West Bank and Gaza and elsewhere, as appropriate), and they are intended to be realistic. Here, our assumptions are determined by a specific target: to reach about 8 percent unemployment by the beginning of 2020. Given the assumptions we have described about the Palestinian labor force, domestic public employment, employment in Israel, and the current level of private employment in the West Bank and Gaza, we assume growth rates of private employment in an independent Palestinian state that would converge to this target unemployment rate in 2019.

Table A.5.4
Assumptions About Palestinian Employment in Israel

|  | | Annual Average Change (%) | | |
| --- | --- | --- | --- | --- |
|  | Initial Level (2005) | 2005–2009 | 2010–2014 | 2015–2019 |
| High contiguity/high integration | 130,000 | 2.0 | 2.0 | 2.0 |
| High contiguity/low integration | 20,000 | 3.5 | 3.5 | 3.5 |
| Low contiguity/high integration | 130,000 | 2.0 | 2.0 | 2.0 |
| Low contiguity/low integration | 20,000 | 3.5 | 3.5 | 3.5 |

Table A.5.5
Assumptions About Palestinian Domestic Public Employment

|  | Annual Average Change (%) | | |
| --- | --- | --- | --- |
|  | 2005–2009 | 2010–2014 | 2015–2019 |
| High contiguity/high integration | 1.7 | 1.0 | 1.0 |
| High contiguity/low integration | 2.9 | 2.5 | 2.5 |
| Low contiguity/high integration | 1.7 | 1.0 | 1.0 |
| Low contiguity/low integration | 2.9 | 2.5 | 2.5 |

Table A.5.6
Assumptions About Palestinian Domestic Private-Sector Employment

|  | Annual Average Change | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2005–2009 | | 2010–2014 | | 2015–2019 | |
|  | % | Jobs | % | Jobs | % | Jobs |
| High contiguity/high integration | 15.2 | 56,400 | 6.5 | 41,100 | 5.5 | 46,800 |
| High contiguity/low integration | 17.2 | 66,500 | 6.9 | 47,900 | 5.5 | 52,000 |
| Low contiguity/high integration | 15.2 | 56,400 | 6.5 | 41,100 | 5.5 | 46,800 |
| Low contiguity/low integration | 17.2 | 66,500 | 6.9 | 47,900 | 5.5 | 52,000 |

We assume that initial (2004) Palestinian domestic private-sector employment is 275,000. Given this starting point, Table A.5.6 illustrates the average annual increases in private-sector jobs that would be needed to reduce the Palestinian unemployment rate to around 8 percent, from an initial (2004) level that we assume to be 42.8 percent. Given these high initial levels, the very rapid growth in the Palestinian labor force, and modest growth in Palestinian employment in Israel (even under high integration) and in the public sector, it is clear that domestic private employment would have to grow at very rapid rates to reach the target level by 2019.

Under the high-integration scenarios, we assume that domestic private employment would grow at an annual average of about 56,400 jobs from 2005 to 2009, or 15.2 percent per year; we assume that this would be followed by more moderate employment growth of 41,100 jobs annually (6.5 percent) from 2010 to 2014, and 46,800 jobs annually (5.5 percent) from 2015 to 2019, yielding an unemployment rate of 8.2 percent by the end of 2019.

For the low-integration scenarios, we assume that domestic private employment would grow by about 66,500 jobs per year between 2005 and 2009, or a 17.2 percent annual average growth rate—fully 20,000 more jobs per year more than under high integration, since more rapid domestic job growth is needed to compensate for less employment in Israel. Under these low-integration scenarios, employment growth would slow to 47,900 jobs annually (6.9 percent) between 2010 and 2014, and to 52,000 jobs annually (5.5 percent) between 2015 and 2019. This would yield a slightly lower unemployment rate of about 8.1 percent by the end of 2019.[36]

Given our assumptions about Palestinian employment in Israel, employment in the domestic public sector, and employment in the domestic private sector, we can then calculate expected levels of unemployment. Figure A.5.1 presents estimates of Palestinian unemployment for the years 2004 to 2019 by scenario type. Initial (2004) unemployment across all scenarios is expected to be 42.8 percent. In the high-integration scenarios, unemployment falls rapidly to 27.7 percent in 2005 because of Palestinian access to jobs in Israel. Sharp reductions in unemployment continue to 2010 (to about 9 percent) because of anticipated growth in domestic employment. Unemployment then hovers around the 8 to 9 percent range for the remaining ten years. In the low-integration scenarios, however, unemployment falls only to 41.9 percent in 2005; domestic job increases are offset to some extent by the reduction of Palestinian employment in Israel. A focus on growing domestic jobs between 2005 and 2010 reduces unemployment sharply to 13.4 percent. Over the remaining ten years, unemployment gradually sinks to the 8 percent level.

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[36] One reason, though not the primary one, why these private-sector growth rates need to be this high is because our model deliberately limits employment growth in the Palestinian public sector to 1 to 2 percent a year. As mentioned earlier, PA employment is already quite high, even by regional standards. High public-sector employment in other Arab countries has contributed to slow rates of growth in private-sector business formation and in total factor productivity as government bureaucracies stifle the creation of new businesses and slow productivity growth through the imposition of regulations designed to extort bribes.

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**Figure A.5.1**
**Estimated Palestinian Unemployment for 2004–2019, by Scenario Type**
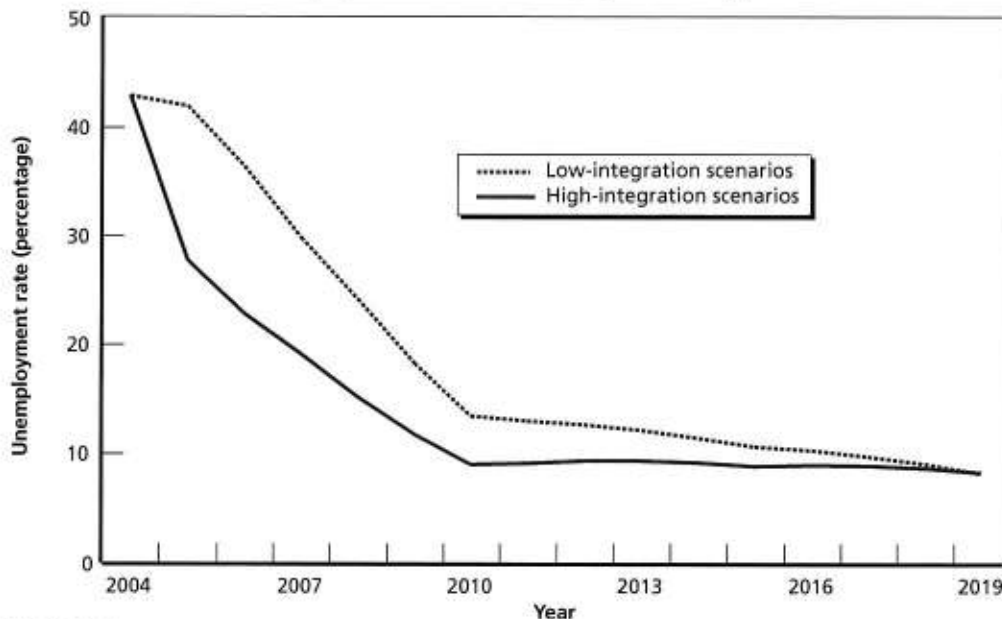


RAND MG146-A.5.1

## Calculating Palestinian National Income

We calculate GNI for every year from 2005 to 2019 by combining our annual GDP figures with estimated income from Palestinian employment in Israel. We then calculate per-capita GNI by dividing by the projected population for that year.

**GDP.** We assume an initial (2004) Palestinian GDP of $3.4 billion. For the years 2005 to 2019, GDP is calculated according to Equation 1, given the assumptions above for TFP, capital, labor, and the elasticities of GDP with respect to capital and labor. Table A.5.7 shows the levels of Palestinian GDP resulting from the model for milestone years, as well as their associated average annual growth rates.

In the high-contiguity/high-integration scenario, GDP increases from the initial 2004 level to nearly $7.5 billion by 2009. This increase reflects high annual average GDP growth rates of 23.7 percent from 2005 to 2009, driven by the reduction of barriers to commerce and domestic employment and by large investments into the Palestinian capital stock. Average growth rates slow 11.3 percent and 10.4 percent from 2010 to 2014 and from 2015 to 2019, respectively, indicating the maturing of the domestic economy.

The high-contiguity/low-integration scenario results in higher average growth rates (24.5 percent) from 2005 to 2009 than the high-contiguity/high-integration scenario, and a higher 2009 GDP (of $7.6 billion). This occurs because of the assumption in the model that domestic employment (both private sector and public sector) would need to grow faster in the low-integration scenarios. Nevertheless, over the long

Table A.5.7
Model Results Regarding Palestinian Gross Domestic Product

| | GDP (in millions of dollars) | | | | | | |
| | 2005–2009 | | | 2010–2014 | | 2015–2019 | |
| | 2004 Initial Level | 2009 Level | Annual Average Change (%) | 2014 Level | Annual Average Change (%) | 2019 Level | Annual Average Change (%) |
|---|---|---|---|---|---|---|---|
| High contiguity/ high integration | 3,420 | 7,480 | 23.7 | 11,710 | 11.3 | 17,810 | 10.4 |
| High contiguity/ low integration | 3,420 | 7,610 | 24.5 | 11,680 | 10.7 | 17,040 | 9.2 |
| Low contiguity/ high integration | 3,420 | 7,260 | 22.4 | 10,960 | 10.2 | 15,910 | 9.0 |
| Low contiguity/ low integration | 3,420 | 7,020 | 21.0 | 10,180 | 9.0 | 14,180 | 7.9 |

term this scenario is outperformed by the high-contiguity/high-integration scenario in terms of growth rates and GDP levels.

Both low-contiguity scenarios perform less well than the high-contiguity scenarios, with the low-integration scenario noticeably lagging by 2019 with a GDP that is 20 percent lower than that of the high-contiguity/high-integration scenario.

**Remittances.** To calculate the contribution of remittances by Palestinians working in Israel to Palestinian GNI, we begin with data on the average monthly wage of Palestinians working in Israel in 1999 (UNSCO, 2001a). We adjust this wage upward to account for moderate growth between 1999 and 2005, and we then convert it into dollars using current exchange rates. Consequently, we take the initial (2004) average wage for Palestinians working in Israel to be $5,370 annually. We increase this wage every year from the initial level by 3 percent. For simplicity, we also assume that 100 percent of the wages go to remittances.

Table A.5.8 shows the total amount of remittances for milestone years and their growth for the three periods of interest. In the high-integration scenarios, remittances jump substantially (61.7 percent) from the initial (2004) level of $215 million to the 2009 level of $877 million. This jump reflects the fact that by 2009 there are assumed to be 100,000 more Palestinians working in Israel than there were in 2004. This growth moderates to 5.6 percent between 2010 and 2014, and between 2015 and 2019, given that the model assumes only small increases in Palestinians seeking employment in Israel over time. By 2019, remittances total just over $1.4 billion.

By contrast, in the low-integration scenarios we assume that the number of Palestinians working in Israel would drop by one-half from initial levels (from 40,000 to 20,000) and then slowly increase. Thus remittances drop to only $143 million by 2009, and increase to only $272 million by 2019.

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**Table A.5.8**
**Model Results Regarding Remittances from Palestinians Working in Israel**

| | Remittances (in millions of dollars) | | | | | | |
| | 2005–2009 | | | 2010–2014 | | 2015–2019 | |
| | 2004 Initial Level | 2009 Level | Annual Average Change (%) | 2014 Level | Annual Average Change (%) | 2019 Level | Annual Average Change (%) |
|---|---|---|---|---|---|---|---|
| High contiguity/ high integration | 215 | 877 | 61.7 | 1,122 | 5.6 | 1,437 | 5.6 |
| High contiguity/ low integration | 215 | 143 | –6.7 | 197 | 7.5 | 272 | 7.6 |
| Low contiguity/ high integration | 215 | 877 | 61.7 | 1,122 | 5.6 | 1,437 | 5.6 |
| Low contiguity/ low integration | 215 | 143 | –6.7 | 197 | 7.5 | 272 | 7.6 |

**GNI.** We then compute Palestinian per-capita GNI by summing GDP and re-mittances for a given year and dividing by the total population. Population estimates come from the IMF's (2001) projections in combination with linear extrapolation. The initial (2004) per-capita GNI is estimated to be $1,110, down from $1,890—which existed just prior to the start of the current intifada. Table A.5.9 illustrates the change in per-capita GNI by scenario from this initial level to 2019.

In the high-contiguity/high-integration scenario, per-capita GNI surpasses the pre-intifada level within the first five years ($2,160) and nearly doubles it by 2019 ($3,740). These results are attributed to the reduction in barriers to commerce because of contiguity and the access to Israeli labor and goods markets.

The high-contiguity/low-integration and low-contiguity/high-integration sce-narios perform less well; although they too surpass the pre-intifada level by 2009, they only grow per-capita GNI by 77 to 78 percent as of 2019. The low-contiguity/low-integration scenario, by contrast, does not reach the pre-intifada level by 2009. By 2019, its per-capita GNI only reaches $2,810—a 48 percent improvement over 1999.

Figure A.5.2 plots per-capita GNI growth between 2004 and 2019 for every sce-nario. In doing so, it allows for ready comparisons of Palestinian performance across different scenarios. The plots in Figure A.5.2 show that high contiguity and high in-tegration would provide the Palestinian state more rapid growth in per-capita GNI than the other scenarios. This growth remains strong throughout the entire 2004 to 2019 time frame. Per-capita GNI levels in the high-contiguity/low-integration and low-contiguity/high-integration scenarios differ somewhat during the first five years of independence, but by 2019 they have essentially converged. The low-contiguity/low-integration scenario performs less well. It is bested by all other scenarios, with

**Table A.5.9**
**Estimated Palestinian Per-Capita GNI for 2004–2019 (under each scenario, in 2003 dollars)**

| | Actual GNI (1999) | Estimated GNI Per Capita | | | | 1999–2019 % change |
|---|---|---|---|---|---|---|
| | | 2004 | 2009 | 2014 | 2019 | |
| High contiguity/ high integration | $1,890 | $1,110 | $2,160 | $2,860 | $3,740 | 97.5% |
| High contiguity/ low integration | $1,890 | $1,110 | $2,000 | $2,640 | $3,370 | 77.6% |
| Low contiguity/ high integration | $1,890 | $1,110 | $2,100 | $2,690 | $3,370 | 78.0% |
| Low contiguity/ low integration | $1,890 | $1,110 | $1,850 | $2,310 | $2,810 | 48.3% |

**Figure A.5.2**
**Estimated Palestinian Per-Capita GNI for 2004–2019, by Scenario Type**
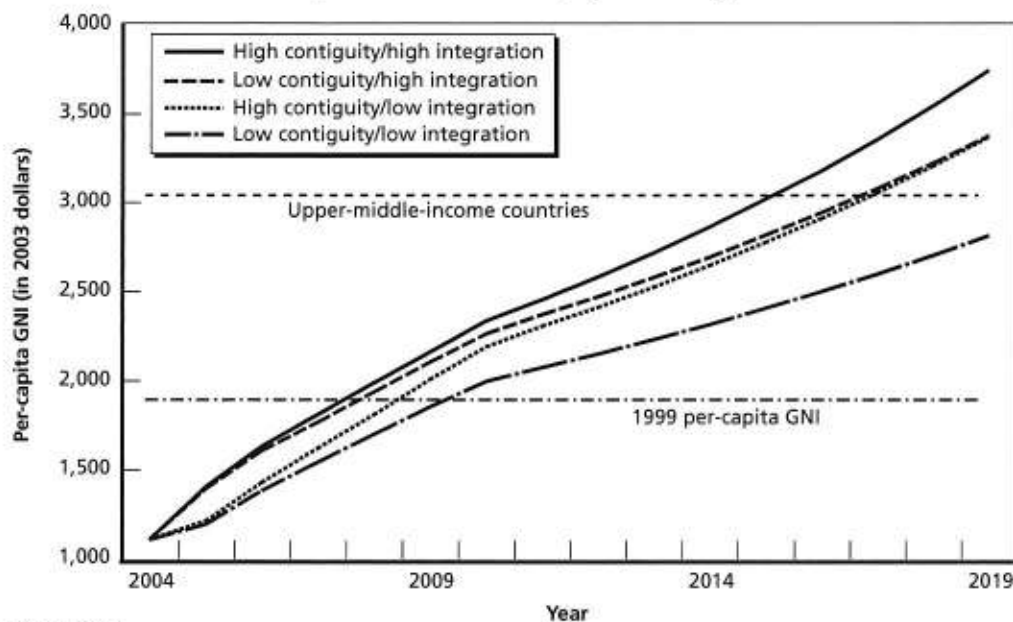


RAND MG146-A.5.2

per-capita GNI in 2019 almost $1,000 less than that produced in the high-contiguity/ high-integration scenario.

Figure A.5.2 also allows for comparisons with different benchmarks. It displays the 1999 pre-intifada per-capita GNI ($1,890) and the World Bank's lower bound for designation as an upper-middle-income country ($3,036). The plots show that by 2009 all scenarios but the low-contiguity/low-integration scenario have surpassed pre-intifada levels. Additionally, they indicate that in these same scenarios Palestine will

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be an upper-middle-income country according to the World Bank by 2017. Under the low-contiguity/low-integration scenario, Palestine remains a lower-middle-income country at least through 2019.

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http://www-wds.worldbank.org/servlet/WDSServlet?pcont = details&eid = 000094946_9910130708485 (as of January 22, 2004).

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CHAPTER SIX

# Water

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## Summary

Clean and sufficient water for domestic consumption, commercial and industrial develop-
ment, and agriculture is a requirement for a viable Palestinian state. The existing level of
water resource development and sharing of water resources between Israelis and Palestin-
ians does not meet this requirement today and is even less likely to do so as the Palestinian
population grows over the next several decades. In addition, current water and waste man-
agement practices are degrading both surface streams and rivers and underground water
resources. In this chapter, we describe the major water resource issues facing the Palestin-
ians, outline policy options to ensure that a Palestinian state has clean and sufficient water
by 2015,[1] and present a modeling approach and preliminary results that suggest promising
strategies and their costs for addressing these water management issues.

The majority of the Palestinian water supply is provided by springs and wells fed by
underground aquifers that are shared with Israel. Current water resource development
provides only about one-half of the World Health Organization's per-capita domestic wa-
ter requirement and limits irrigation and food production. Furthermore, the amount of
water extracted by the Palestinians and Israelis from most of the region's aquifers exceeds
the natural replenishment rate, signifying that the resources are being used unsustainably.
Finally, new natural sources of water are limited; and desalination, the most viable alter-
native, is still expensive, capital intensive, and sensitive to fuel price volatility.

The long-term challenge for Palestinian water resource managers is to sustainably
increase water supply while managing the water demand of the Palestinian population.
Options for increasing the water supply include increasing groundwater use accommo-
dated by use reduction by Israel, increasing rain and storm water capture, and increas-

[1] To be consistent with the rest of the report, cost numbers are presented for ten years through 2014. However, to be
consistent with other plans for the region, we use 2015 and 2020 goals for adequate water supplies and minimum levels
of consumption, so plans are assumed to run through 2020 even though we only show cost numbers through 2014.

ing desalination capabilities where no other options exist. Demand can be managed through the smart application of water efficiency technologies, water reuse methods, and infrastructure improvements.

Through the use of a water allocation model based on the work of CH2M HILL (2002b), we estimate a base case cost of supplying water and sanitation through 2014 to be over $4.9 billion. We also demonstrate that a more diverse set of water management strategies that includes increased demand management can be more effective and more flexible in meeting future Palestinian water needs. These strategies could reduce costs by as much as $1.3 billion in the base case. If population growth and fuel costs are greater than expected, then costs with standard management strategies could be almost $6 billion. However, our proposed improved strategies provide an even greater benefit, saving almost $2 billion.

## Introduction

One of the most fundamental challenges facing the Middle East is ensuring sufficient water for future prosperity. Water security is especially critical for a future Palestinian state: water resources are scarce in the West Bank and Gaza, and supplies must increase to accommodate development. Current consumption from most groundwater sources exceeds the rate of recharge and is unsustainable.[2] According to recent estimates, Israelis and Palestinians are overdrawing from the aquifers underlying the West Bank by more than 170 million cubic meters per year (MCM/yr) (CH2M HILL, 2002a). Overdraft from the Gaza Aquifer exceeds recharge by about 65 MCM/yr (PASSIA, 2003).

Water quality, inadequate water distribution, and sewage infrastructure are also major issues. Water problems in the West Bank and Gaza have already led to significant health problems and hinder efforts to alleviate poverty and to encourage development. The uncertain political environment has significant implications for the water infrastructure. The United Nations estimated that Israeli incursions into the West Bank and Gaza, in just the first quarter of 2002, caused almost $7 million of physical damage to water and sewage infrastructure (UNDP, 2002).

Water management decisions also have strong links to agriculture and energy consumption. For example, the agricultural sector is the primary user of water in the region, and many options for increasing the water supply will be energy intensive. As a result, water resource planning should be undertaken as part of a broader comprehensive planning process that considers the many important interconnections among the water, energy, and agricultural sectors.

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[2] The process by which surface water flows into aquifers is known as "recharge." The rate of recharge is particularly important because if groundwater withdrawals exceed the recharge rate, the aquifer will be depleted.

We argue that the following should be the four major planning goals for 2015:

1. Increase water availability to meet minimum per-capita consumption while managing demand through efficiency and reuse.
2. Reduce utilization of groundwater resources to sustainable levels.
3. Upgrade and improve the efficiency of the existing water supply and sewage infrastructure.
4. Expand water supply and sewage infrastructure to serve at least 90 percent of the population.

There are many policies that could be implemented to achieve these goals. A prudent planning approach will consider the costs of candidate policies under a wide range of possible water demand and supply scenarios. As we show in this chapter, some policies perform better under uncertainty than others.

Meeting these goals will require overcoming many hurdles, the first of which is negotiating an agreement between the Israelis and Palestinians on the use of shared aquifers. Any proposed water-sharing solution will need to address significant equity issues. Regardless of the solution to sharing water rights, all proposals will ultimately require Israel to reduce withdrawals from aquifers in the West Bank and Gaza to sustainable levels. We assume that the international community will finance alternative supplies to offset water that Israel gives up in any aquifer-sharing agreement. Because desalination is likely the highest-cost option for generating new supplies of water for Israel, we include the cost of desalination to provide an upper bound for our total cost estimates.

In this chapter, we examine potential opportunities and solutions for the water problems in the West Bank and Gaza within the context of the four major planning goals listed above. First, we provide general background on water issues for the Middle East region, to put the West Bank and Gaza issues in context. Second, we outline the historical and current water situation in the Palestinian territories. Third, we describe the major supply, demand, and infrastructure elements of a comprehensive water management strategy. Fourth, we describe our approach to modeling potential policy strategies. Finally, we conclude by discussing some promising options for addressing the water needs of a future Palestinian state.

## Water, Agriculture, and Energy in the Middle East

### Water Scarcity in the Middle East

The world's supply of renewable fresh water is distributed unequally among the world's population, and many regions suffer from water scarcity. To help characterize water stress (the stress on individuals resulting from different levels of water scarcity), the Swedish hydrologist Malin Falkenmark determined the "minimum level of water needed per capita to maintain an adequate quality of life in a moderately developed

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country" (Falkenmark and Widstrand, 1992). Falkenmark found that these domestic needs could be met with roughly 100 liters per person per day (or 36.5 cubic meters per person per year), which has become a minimum objective for United Nations planning around the world. Beyond personal needs, Falkenmark found that each new person increases the water demand of the agricultural, industrial, and energy sectors by a factor of up to 5 to 20 times the amount needed for personal needs. Based on these estimates, Falkenmark developed a water stress index with three thresholds, corresponding to different degrees of water shortage (Engelman and LeRoy, 1997).

- "Water stress" includes countries whose freshwater resources are less than 1,700 cubic meters/person/year.
- "Water scarcity" is when freshwater availability falls below 1,000 cubic meters/person/year.
- "Absolute scarcity" is when freshwater availability falls below 500 cubic meters/person/year.

Based on 1996 UN projections, the population living in absolute scarcity could increase from 60 million to 185 million by 2025. In 1995, the Middle East region had an aggregate freshwater availability of 1,420 cubic meters per capita, indicating that it suffers from water stress (World Resources Institute et al., 1998).

Although the Middle East suffers from water stress, the degree of this stress varies substantially between and within countries. The water indices for individual countries in this region, for example, range from less than 100 cubic meters per person (absolute scarcity) to nearly 5,500 cubic meters per person (no water stress) (Saghir, Schiffler, and Woldu, 2000). Figure 6.1 contrasts the available water supply for countries in the

**Figure 6.1**
**Estimated Amount of Water That Could Be Available with Increased Water Resource Development to Select Countries Based on Rainfall, Topology, and Subsurface Characteristics**
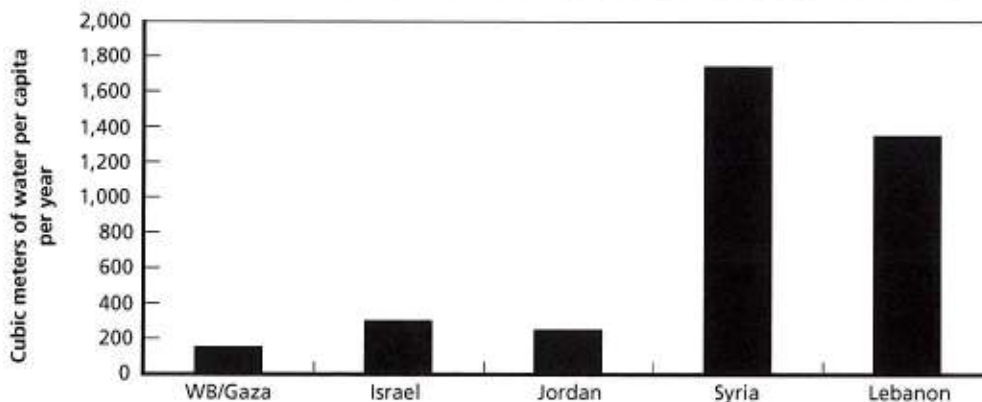


SOURCE: Gardner-Outlaw and Engelman, 1997.
RAND MG146-6.1

region (the numbers representing Syria and Lebanon reflect national figures, not just those portions within the Jordan River basin). The available water resources are determined by a region's rainfall, topology, and subsurface characteristics. Together, these parameters define a basin, which typically consists of a variety of water sources, including surface sources such as lakes and rivers as well as groundwater aquifers.

### The Jordan River

The Jordan River, which is approximately 360 km long, flows through Lebanon, Syria, Jordan, Israel, and the West Bank (see Figure 6.2) and supplies more than half of the region's water supply. For Israel and the West Bank, the Jordan River, its tributaries, and the aquifers underlying the area are the only natural sources of fresh water.

The upper Jordan River is fed by three springs: the Hasbani in Lebanon, the Banias in the Golan Heights, and the Dan in Israel. The upper Jordan then flows into Lake Tiberias in Israel from the north. Just south of Lake Tiberias, the Yarmuk River, which is shared by Jordan and Syria, enters the lower Jordan River from the east, as do several other smaller streams. The lower Jordan River flows south from Lake Tiberias toward the Dead Sea and has been significantly reduced in volume during recent years, since no water has been released from Lake Tiberias. At the same time, riverside communities deposit sewage, agricultural runoff, and industrial discharges back into the Jordan River downstream of where they withdraw water from the river. As a result, the dwindling waters of the Jordan River become progressively more polluted and saline as they flow toward the Dead Sea. These practices have reduced the natural surface water flow for the lower Jordan River from about 1,400 MCM per year to 300 MCM per year by the early 1990s (National Research Council, 1999).

Both Israel and Jordan have significant water diversion systems located upstream in the Jordan River basin. These systems transport water to more-distant locations, largely for use in irrigated agriculture. For example, Israel's national water carrier diverts 350 MCM per year of water from Lake Tiberias toward coastal agricultural regions closer to the Mediterranean Sea and the Negev desert. Jordan's East Ghor Canal withdraws 150 MCM per year from the Yarmuk River just before it flows into the Jordan River basin.

Aquifers are rain-fed underground stores of water that can be utilized through wells and springs. Israel, Gaza, and the West Bank are supplied with groundwater from the Coastal and Mountain Aquifers. The Mountain Aquifers that supply much of Israel and the West Bank complements surface water resources. The Coastal Aquifer, while not technically part of the Jordan River basin, is the sole water supplier to Gaza and parts of Israel. The renewable water supply is the sum of precipitation and imports of water, minus the water not available for use through evaporation and exports. Renewable aquifer yields are particularly difficult to estimate because of limited sharing of data, poor measurement techniques, and misclassification of water resources data. However, we use the following estimates for sustainable yield: 339 MCM/yr for the

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**Figure 6.2**
**The Jordan River Basin**



SOURCE: Adapted from Thomas R. Stauffer, *Water and War in the Middle East: The Hydraulic Parameters of Conflicts*, Washington, D.C.: The Center for Policy Analysis on Palestine, (currently The Palestine Center) Information Paper Number 5, July 1996. ©The Jerusalem Fund.
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Mountain Aquifers (CH2M HILL, 2002a), and 55 MCM/yr for the Gaza Aquifer (PASSIA, 2003).

There is significant regional and seasonal variation in rainfall, which affects the amount of water that recharges the groundwater and surface water and sustains rain-fed crops. In the northern sections of Israel and the West Bank, rainfall can be as much

as 1,000 mm/yr; in the south it can be less than 30 mm/yr. Almost 90 percent of the land receives less than 300 mm/yr. Most agricultural production in the region occurs in these areas of less precipitation, where the rainfall is technically insufficient for most agricultural purposes. Almost three-quarters of the rainfall occurs from December to February, with almost no rainfall between May and October. High evaporation rates exacerbate the dry conditions by reducing the amount of rainfall available for use and recharge. Only about 20 percent of rainfall can be considered as adding to the renewable water supplies (National Research Council, 1999).

There is also significant annual variation; almost twice as much rain falls in wet years as in average years. As there is little storage capacity other than in aquifers, this variation significantly affects available supplies (National Research Council, 1999). The Middle East has been experiencing a severe drought. Most of the water plans that are developed for the region assume a starting point of normal rainfall; however, in reality, all plans should start with a deficit. In addition, projections of future rainfall assume historical weather patterns, in some cases using 30 years of historical information. However, it is unclear how relevant extended historical observations are, given potential variations in climate. The process of climate change, whether caused by natural variations or human-induced, would likely change both average weather conditions and the variability of the weather (i.e., both the statistical mean and variance would likely change). Such changes would make historic averages misleading, further complicating efforts to address the challenges imposed by water scarcity in the region. Clearly, overcoming the challenges described above will require more than finding solutions under historic average conditions.

### Integrated Management

Since water supply consumption and disposal are interrelated, managing water resources in the Jordan River basin requires an integrated approach. Freshwater supplies come from groundwater aquifers, some surface water supplies, and rainfall. Water is consumed for domestic, industrial, commercial, and agricultural purposes. Most municipal and industrial water in the West Bank and Gaza is currently untreated after use. This wastewater is deposited back into rivers, streams, septic systems, and holding ponds, ultimately flowing to the Mediterranean or percolating back into the aquifers. A small volume of treated wastewater is used for irrigation. Finally, irrigation runoff flows back to surface streams and rivers, percolates into the aquifer, or evaporates.

**Aquifer Management.** Sustainable aquifer management is difficult for several reasons. First, many aquifers underlie several countries, management districts, and/or property owners. Second, the use of aquifers is decentralized and therefore difficult to monitor and control. Finally, although aquifers are a common resource, the benefit of aquifer use accrues to the individual or group that pumps the water, whereas the costs of use are imposed upon all other users. Individuals, therefore, can compromise the resource for all users.